PROJECT CHARGE: 1706

PROJECT TITLE: SPECIAL PROBLEMS

PERIOD COVERED: March 1 - March 31, 1977

PROJECT LEADER: A. C. Lilly

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ELECTRICAL PERFORATION OF TIPPING PAPER (written by A. C. Lilly)

Experiments are under way involving the on-the-fly measurement of paper porosity prior to the design of feedback circuitry to control the porosity by controlling the average spark current. The initial experiments involve a pressure drop measurement and measurements have been carried out at speeds up to 1000 feet per minute.

A new electrode head made of aluminum has been installed in the R and D unit. This was designed in order to overcome the thermal problems with the polycarbonate heads. The initial results have been good.

The patent on the perforator is almost complete. It is expected to be filed in about one week.

Discussions were held with four CO_2 laser manufacturers regarding the use of lasers in paper perforation. The problems in our application are the large number of holes and the high paper speed. It is questionable as to whether the CO_2 laser can be Q-switched fast enough for this application.

CO_2 TOBACCO EXPANSION PLANT MODEL (written by Peter Martin)

The work was resumed on this project in late February with the goals of providing some specific results on the receiver, reservoir and pipe conditions under specified operating parameters.

The flow conditions can be separated into three sections:

1) Completely supersonic flow,
2) completely subsonic flow,
3) a transition phase between the above two which is controlled by the transmission of a normal shock from the receiver to the reservoir.

During this period the work has concentrated on the receiver and the reservoir, and the supersonic and transition phases.

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We have found that the equation of state is appropriate to describe both normal gas and normal liquid phases. We have used this to enable us to calculate the enthalpy, the entropy and the velocity of sound (=$\partial P/\partial G$ at constant S) at any known temperature and density.

The flow of the fluid in the nozzle has been modelled as an isentropic flow of a frictionless supercooled gas, where the transition to an equilibrium state accompanies its entering the main duct. The type of flow is governed by the conditions in the throat of the nozzle. A Mach one velocity ratio at this point corresponds to supersonic flow in the duct. The parameters of the initial slug and the resultant flow conditions are determined by forcing isentropic flow and by equating the enthalpy loss from the reservoir to the gain in kinetic energy.

The variation of the receiver parameters is calculated by equating the change in total energy to the enthalpy carried across the pipe-receiver boundary by the incoming slug. The same approach will be adapted with the reservoir although, to date, all test runs have held its parameters constant.

The transition phase has been changed to allow the normal shock wave to propagate down the pipe (against the flow) in a finite time, as opposed to instantaneously as it was in previous models. The movement and creation of this shock wave is governed by the three standard conservation equations (mass, momentum and energy) with the constraint that the receiver pressure exists on the streamline.

The program can now be run in an on-line mode (as opposed to Batch) using the Fortran Debug Package (FDP). This was achieved by halving the major dimensions of the program and by obtaining permission from J. Wasiuk (computer coordinator) to utilize more core than normally allowed in an on-line operational mode. The results of this have been a more rapid and easier detection of program error and improvements.

A set of experimental results have been obtained from F. Utsch for the pressure and temperature in both the reservoir and receiver during several pilot plant runs. The experimental configuration does not exactly match the program's allowed configuration, but it is hoped that they are close enough to allow us to compare theoretical predictions, and to allow verification or confident amendments to our methods of handling the vena contracta and frictional effects.

An initial approach has been made to the Newport News Shipbuilding Company to determine whether any of the computer

programs that they have for handling steam transportation could be applied to this problem. J. Wasiuk is to be thanked for the initial idea and for making the initial contact.

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